Chinese Regional Agricultural Productivity: 20 Years After

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China's agricultural output increased ~ 200% since the 1978 HRS reforms.

Are Chinese rapid growth rate sustainable?

What is the main source of this growth?

Is it *scale* or is it *innovations*?

- **Important** because one implies long run growth while the other source does not

What is the evidence?

- Rapid increase in input use
- Adoption of new technologies
- Studies of the economy point towards scale

- 20 years after the HRS reforms of 1978
- Growth rates of ag output slowed down in the early 1990's
- Was this additional evidence that most of the growth is scale based?
- Or is it that uncertainty due to potential of policy reform in 1998?
- Could this have affected agricultural productivity?

Other Studies of the 1990's: Provincial Data

- Lambert: 1993-95, Tornquist Index, 5.8%
- Jin et al.: 1994-1995, Tornquist Index, -3.1%
- Meade: 1993-1995, Cobb-Douglas, 0.19%
- Tong and Fulg.: 1993-2001, Translog (1%) and MI (0.1%)
- Deckle et al.: 1994-2003, Cobb-Douglas, 6.58%

Objectives of this study:

- Examine *regional* agricultural productivity
- 29 Provinces (Tibet not included)
- Period 1993-2005
- 20 years after the 1978 reform
- Use China's Statistical Yearbook data, not FAO
- Identify if differences in productivity across provinces are associated with irrigation, education and public agricultural expenditures.

Chronology of Major Ag. Policy Reforms:

1) 1978 HRS

2) 1994 elimination of food-rationing

3) 1995 Grain-Bag responsibility system

4)1998 second HRS

5) 2003 elimination of taxes to sector

Data

- Output: agricultural output in real Yuans

- Four traditional inputs:

  Land (in ha)
  Agricultural machinery (in KW)
  Labor (persons)
  Fertilizer (tons)

- Three efficiency changing variables:

  Education (ratio)
  Irrigation (ratio)
  Public expenditures in agriculture (expenditures on agricultural water conservancy, meteorology, resource investigation, subsidies to well drilling, sprinkling irrigation projects and improved varieties)

- Source: China Statistical Yearbook

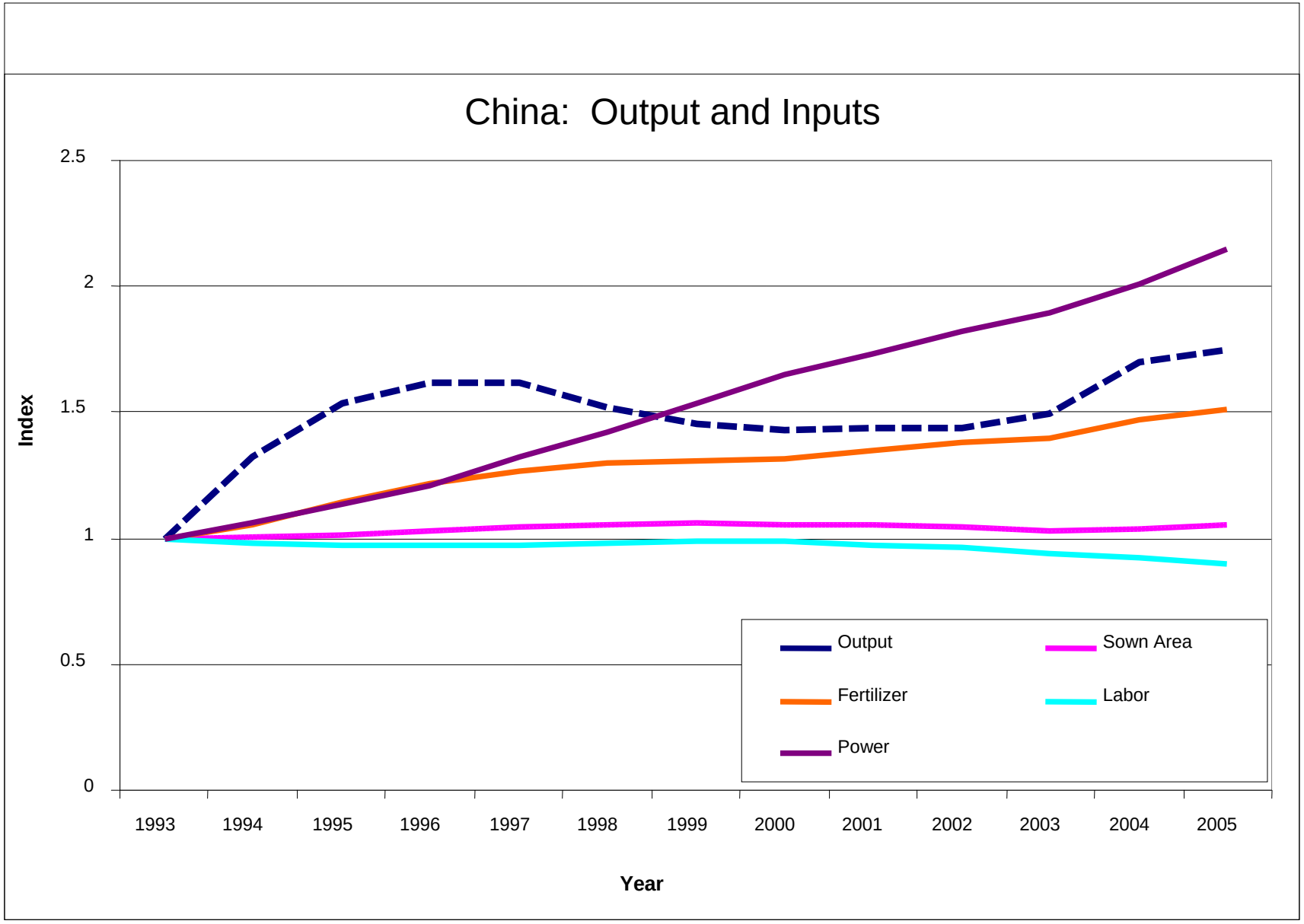
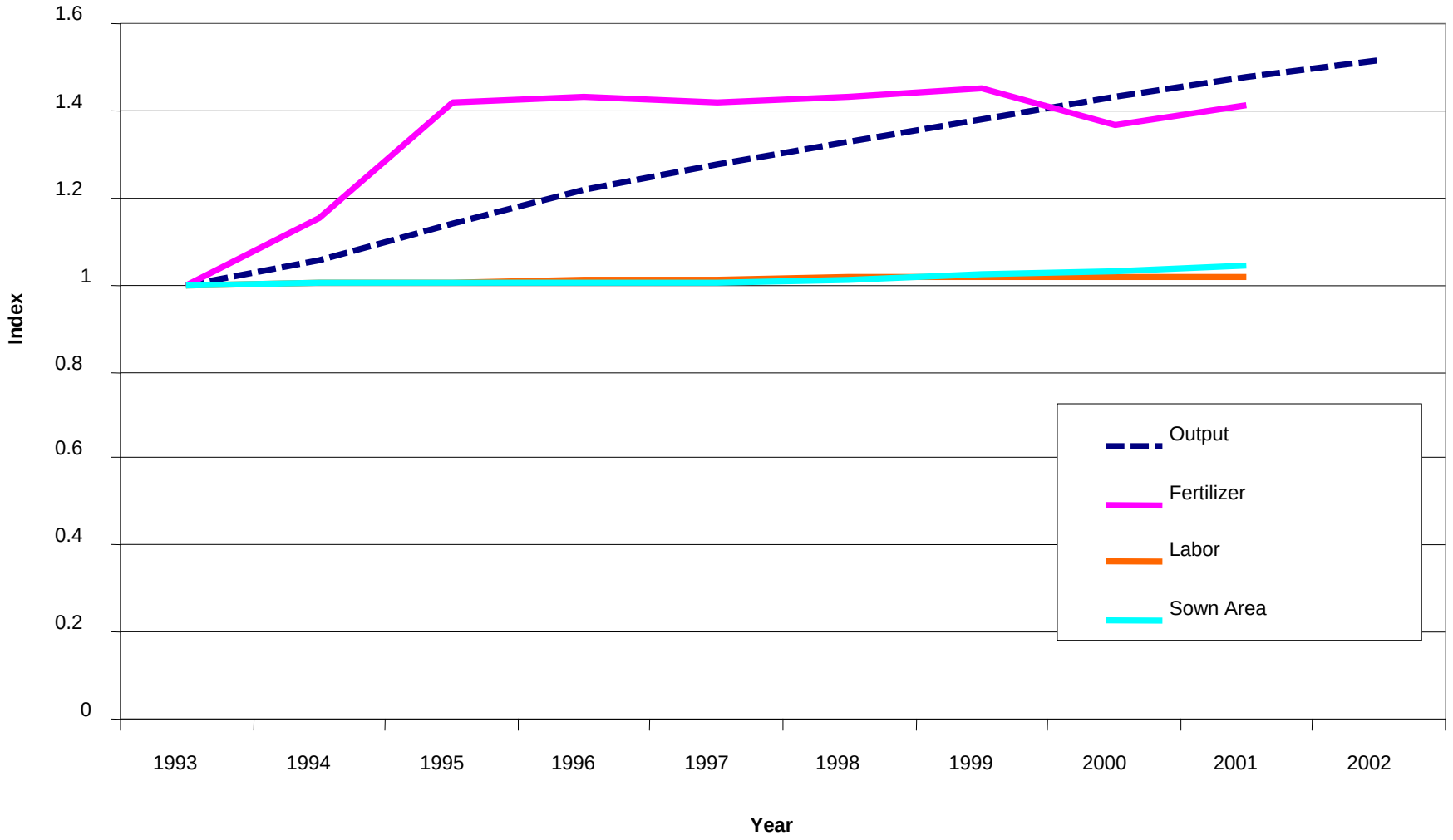
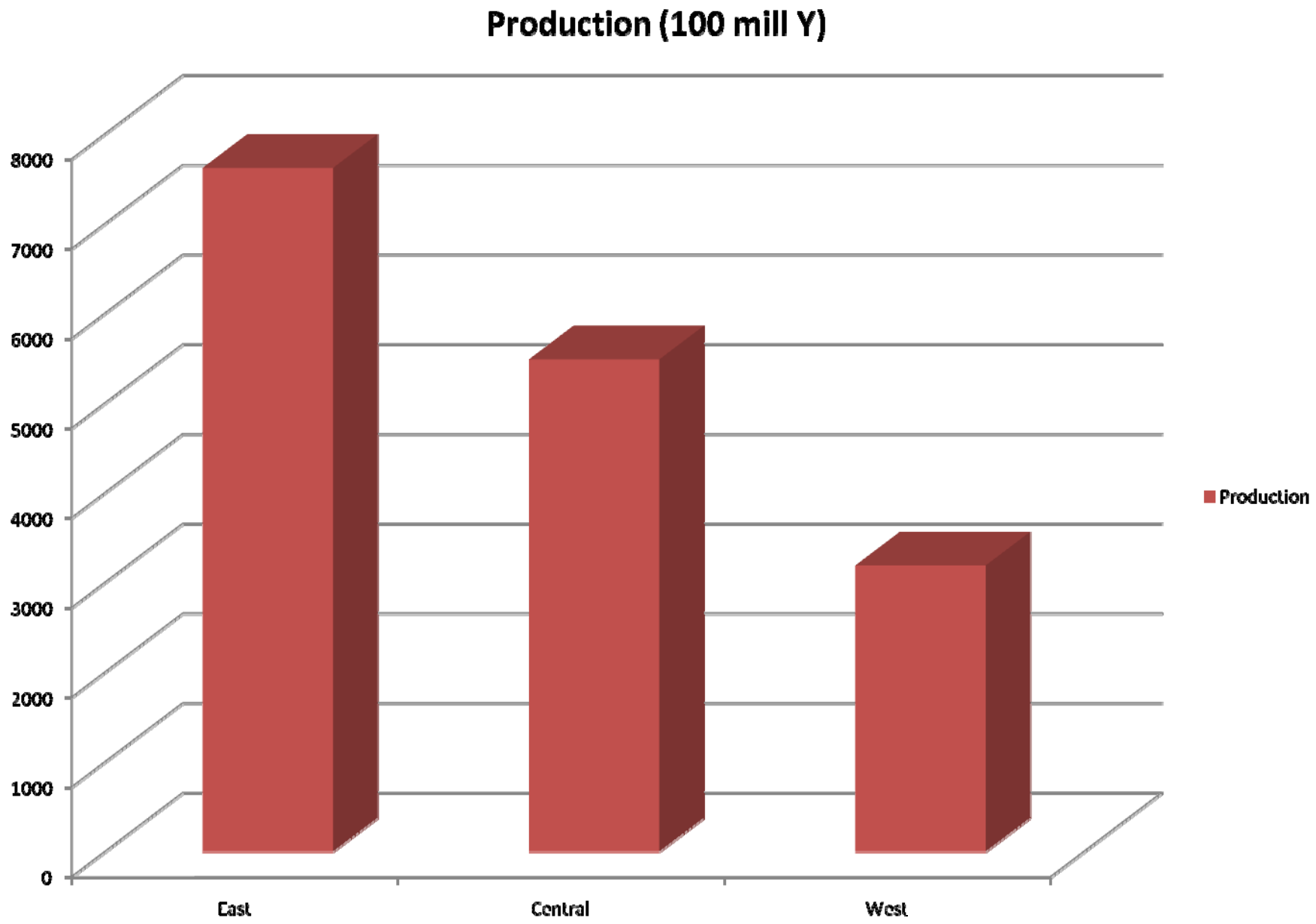
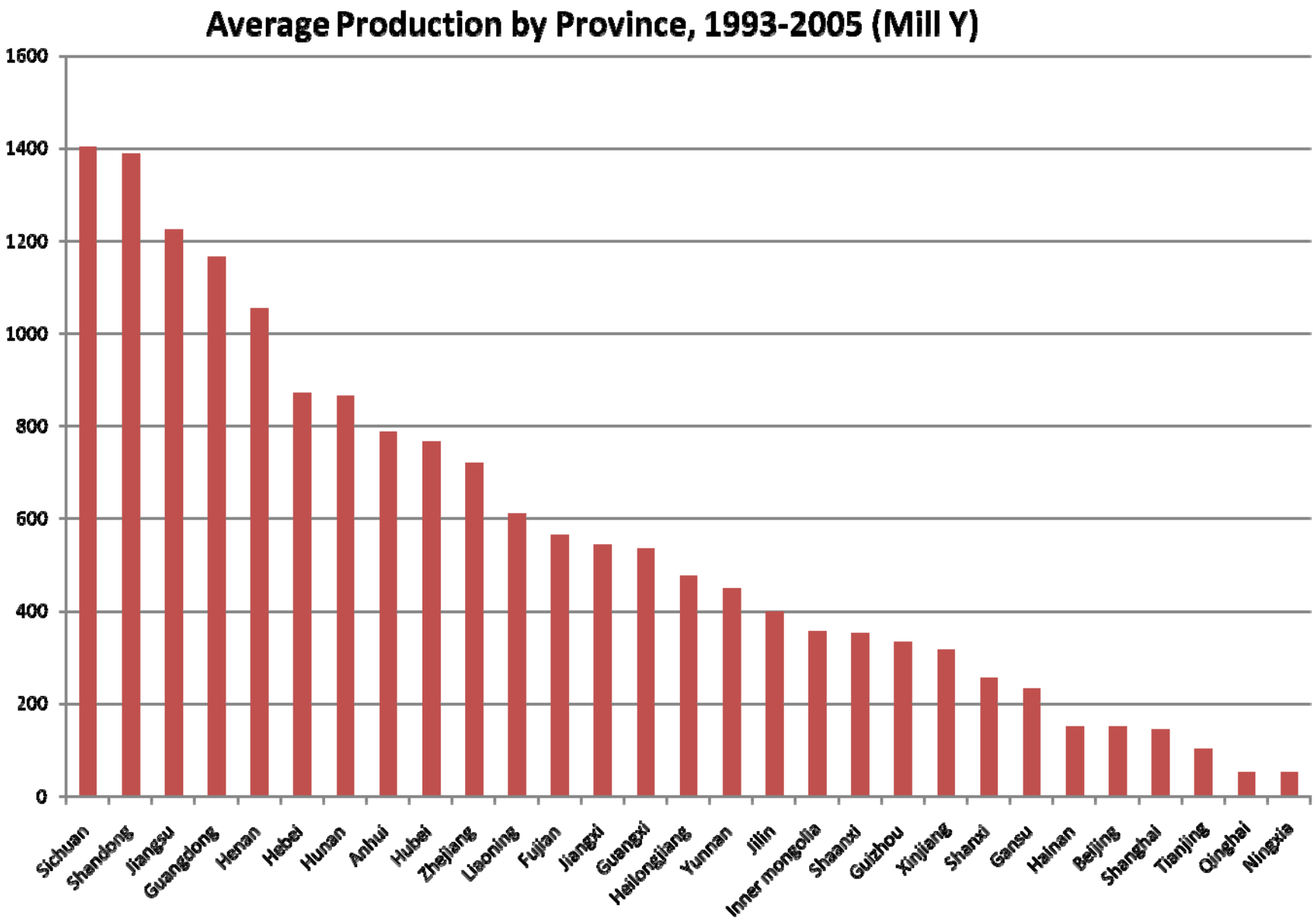
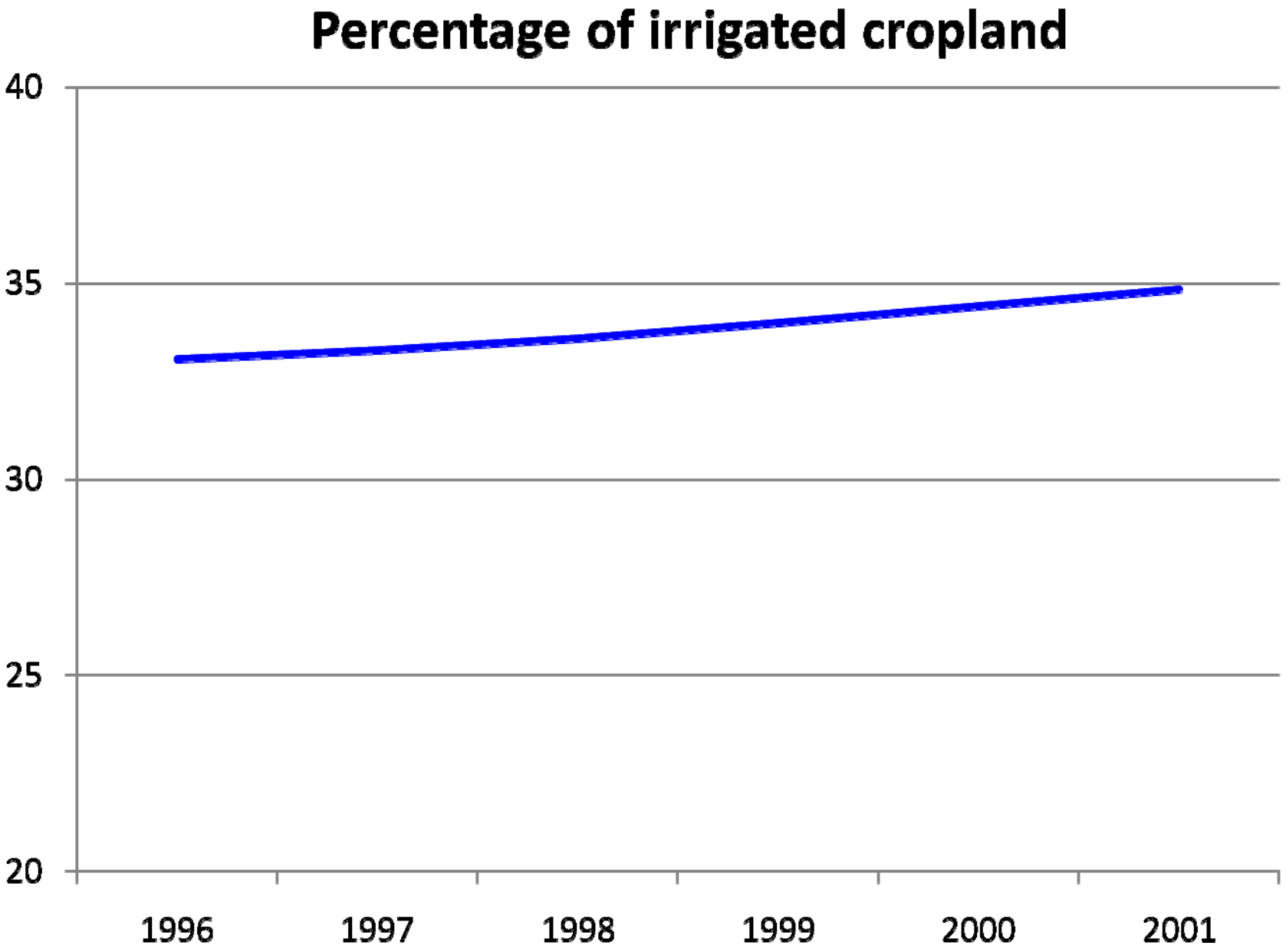

China: Output and Inputs
2.5
2
1.5
1
0.5
0
Index
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year
Output
Sown Area
Fertilizer
Labor
Power

Figure 2: Series of Outputs and Inputs (FAO)

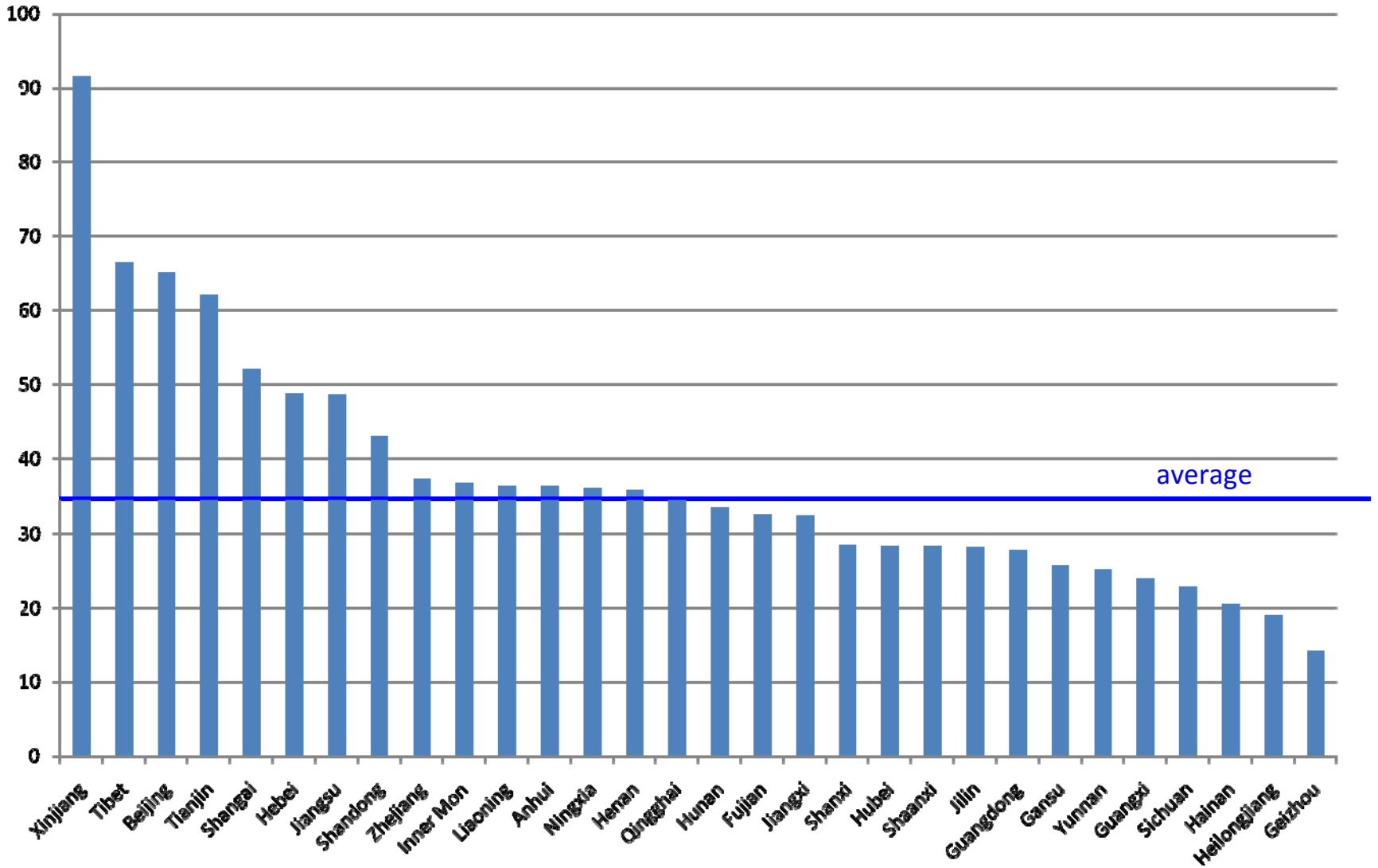



Production (100 mill Y)
8000
7000
6000
5000
4000
3000
2000
1000
0
East
Central
West
Production


Average Production by Province, 1993-2005 (Mill Y)
1600
1400
1200
1000
800
600
400
200
0
Sichuan
Shandong
Jiangsu
Guangdong
Henan
Hebei
Hunan
Anhui
Hubei
Zhejiang
Liaoning
Fujian
Jiangxi
Guangxi
Heilongjiang
Yunnan
Jilin
Inner mongolia
Shaanxi
Guizhou
Xinjiang
Shanxi
Gansu
Hainan
Beijing
Shanghai
Tianjing
Qinghai
Ningxia


Percentage of irrigated cropland
40
35
30
25
20
1996
1997
1998
1999
2000
2001

Percentage of land irrigated per province



Define productivity (TFP) as output per unit of input:

TFP= Output Index/Input Index

TFP Growth rate: Output growth- Input growth

Concern about using prices as weights

Methods

1) Malmquist Index:

$$M_0(x_{t+1}, y_{t+1}, x_t, y_t) = \frac{D_o^{t+1}(x_{t+1}, y_{t+1})}{D_0^t(x_t, y_t)} \left[\frac{D_o^t(x_{t+1}, y_{t+1})}{D_0^{t+1}(x_{t+1}, y_{t+1})} * \frac{D_o^t(x_t, y_t)}{D_0^{t+1}(x_t, y_t)} \right]^{1/2}$$

MI = *Efficiency change + Technical change*

2) Stochastic Production Frontier:

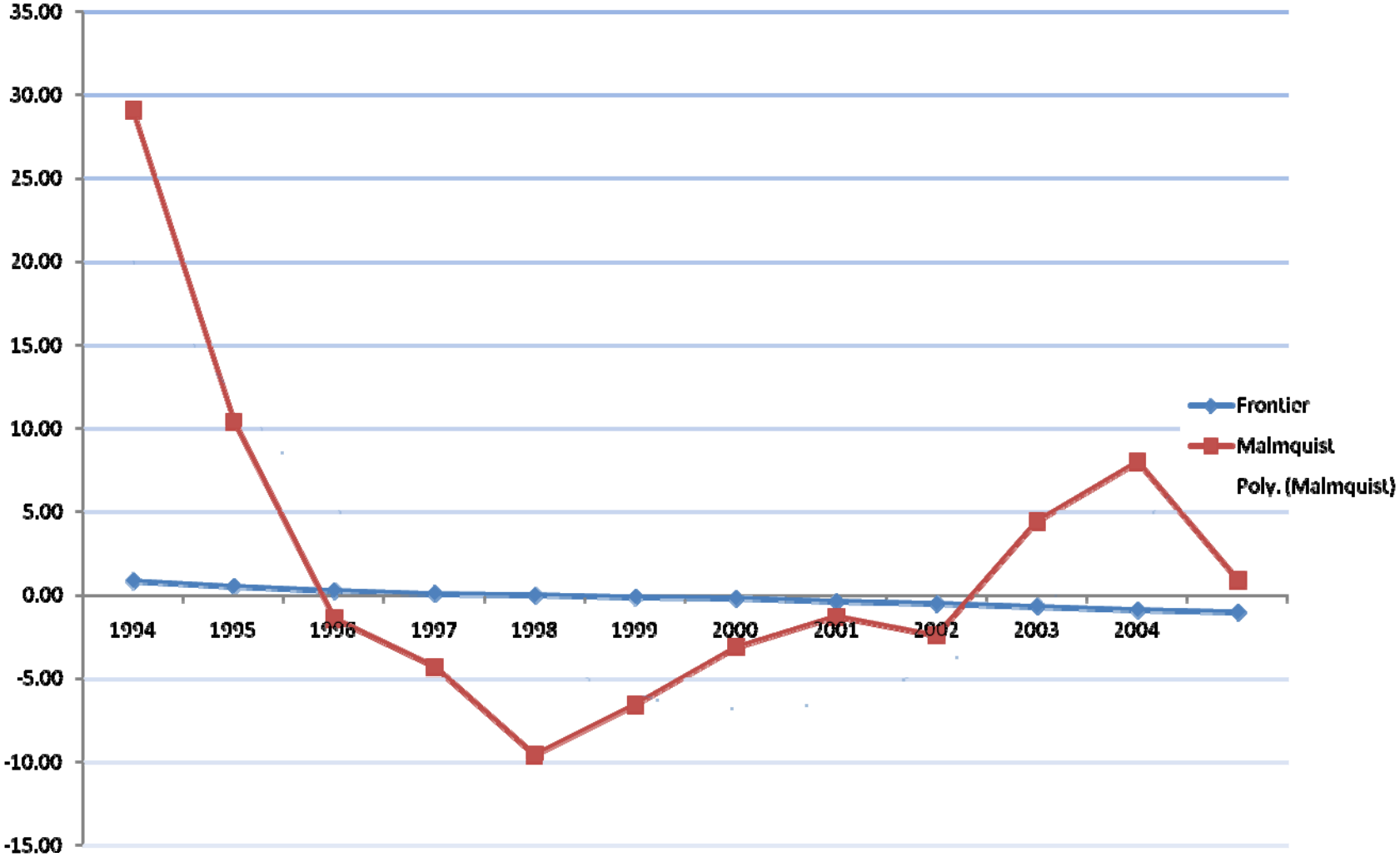
$$\ln Y_{it} = \alpha_0 + \sum_m \alpha_m \ln x_{mit} + \alpha_t t + \frac{1}{2}\sum_m \sum_n \beta_{mn} \ln x_{mit} \ln x_{nit} + \frac{1}{2}\beta_{tt} t^2 + \sum_m \beta_{tm} \ln x_{mit} * t + v_{it} - u_{it}$$

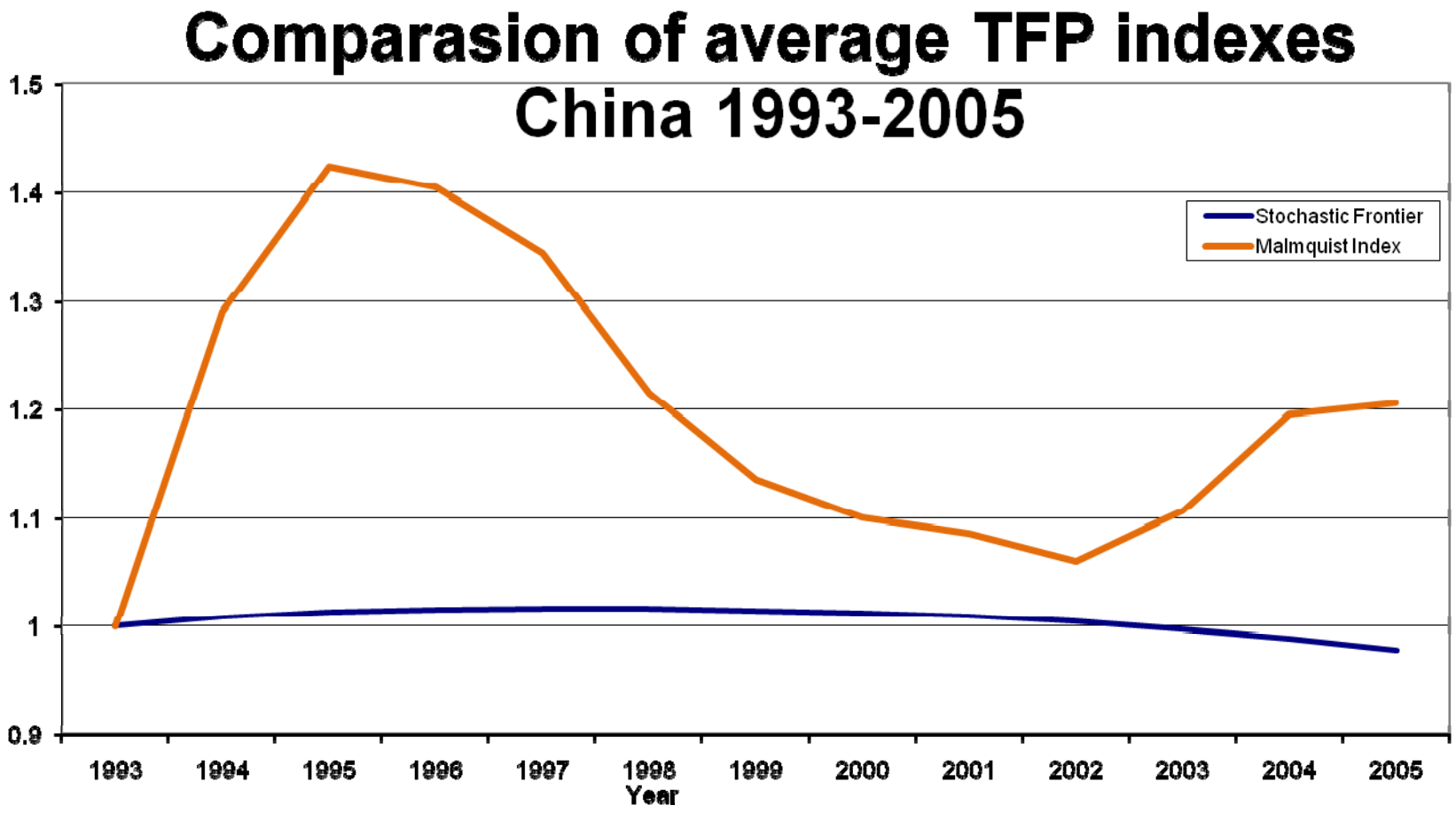
$$TC_{it} = \frac{\partial \ln Y_{it}}{\partial t} = \alpha_t + \beta_{tt} t + \sum_m \beta_{tm} \ln x_{mit}$$

$$TE_{it} = \exp(-u_{it}) \qquad u \square HN(\mu, \sigma_u) \qquad m_{it} = z_{it} \delta$$

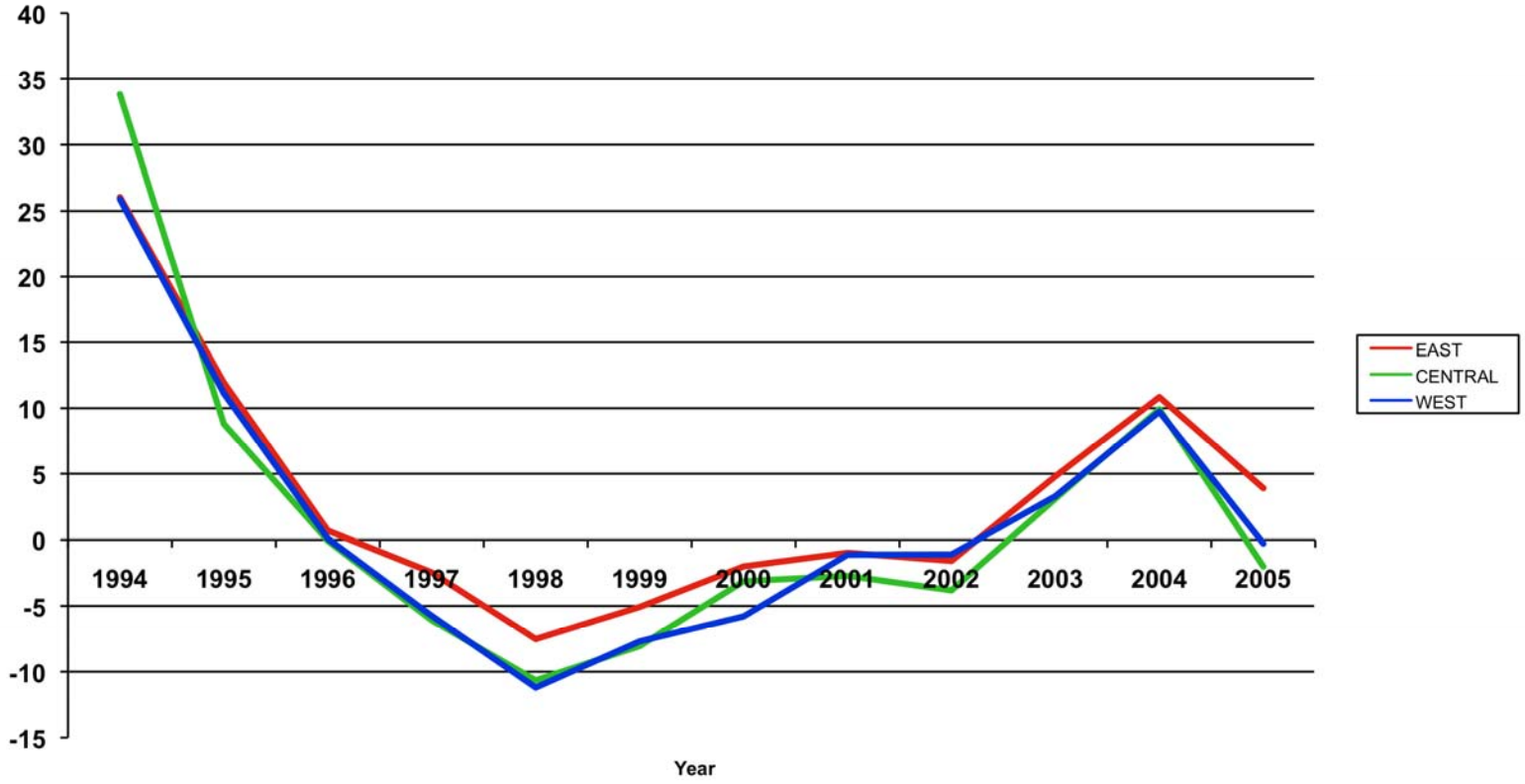
$$T\dot{F}P = \dot{y} - \sum_m \varepsilon_m \dot{x}_m = TC + EC$$

Comparison of TFP Growth Rates for China, 1993-2005, MI and SPF (%)

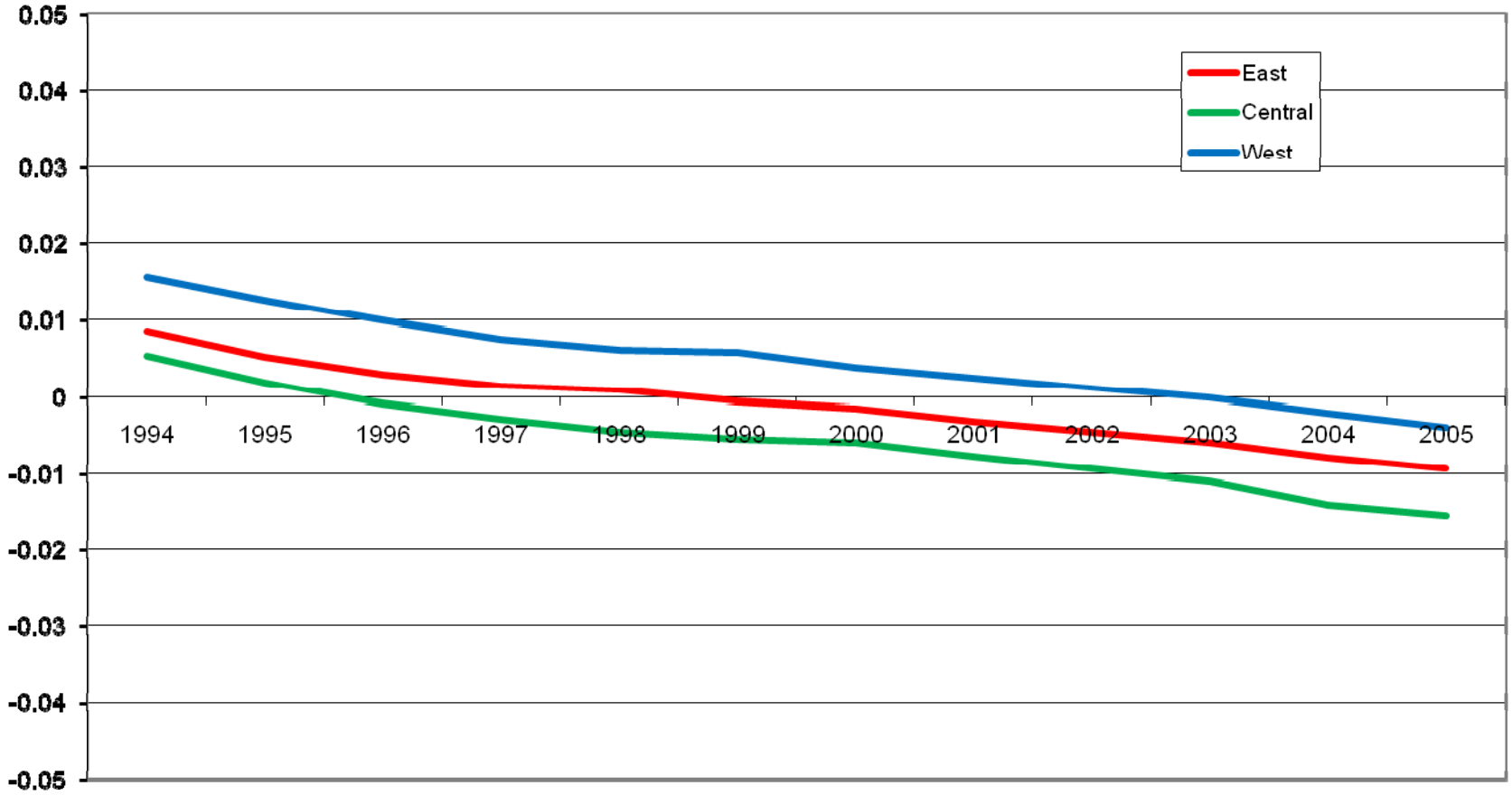



Comparasion of average TFP indexes
China 1993-2005
1.5
1.4
1.3
1.2
1.1
1
0.9
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year
Stochastic Frontier
Malmquist Index

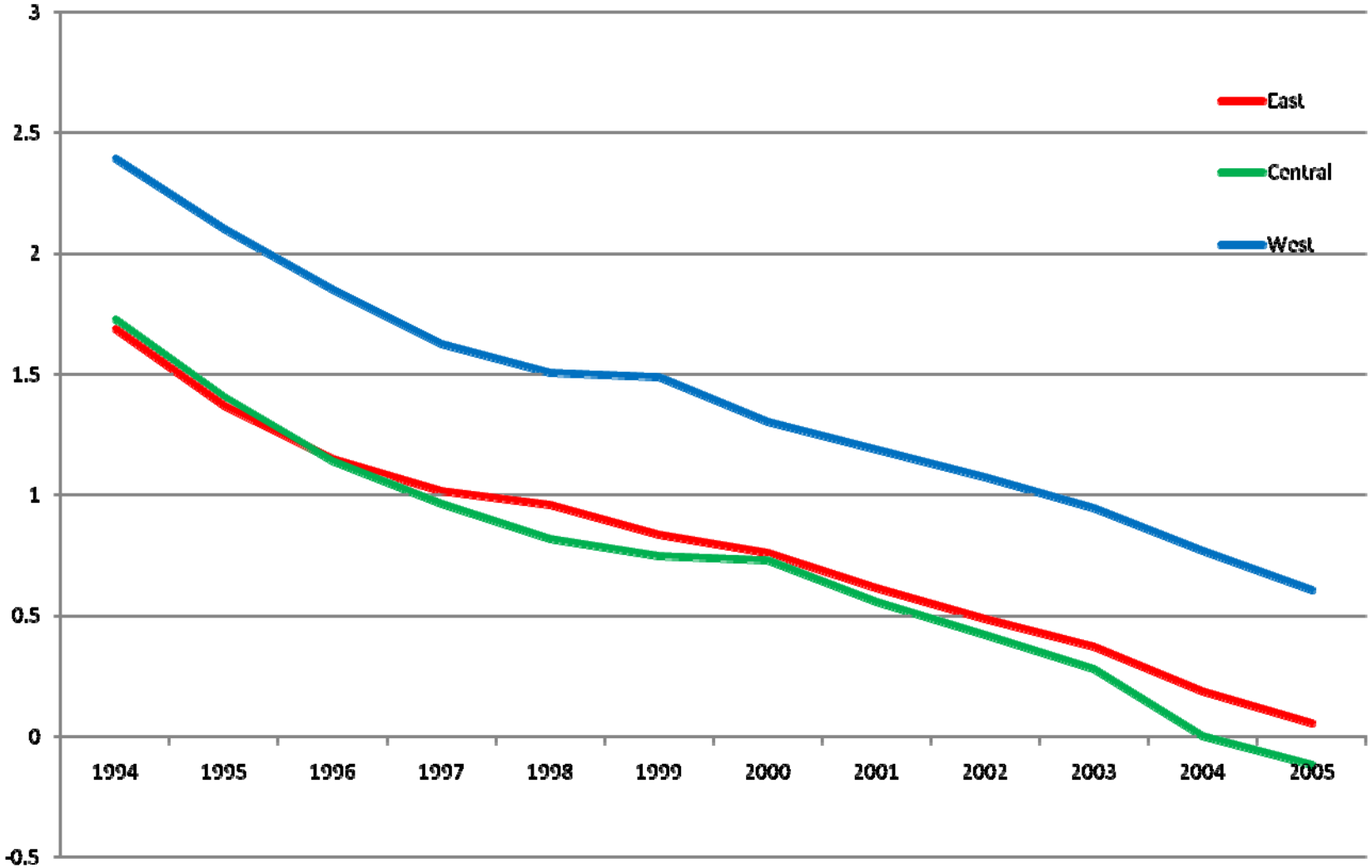
Regional TFP Change Rate
1993-2005, MI (%)



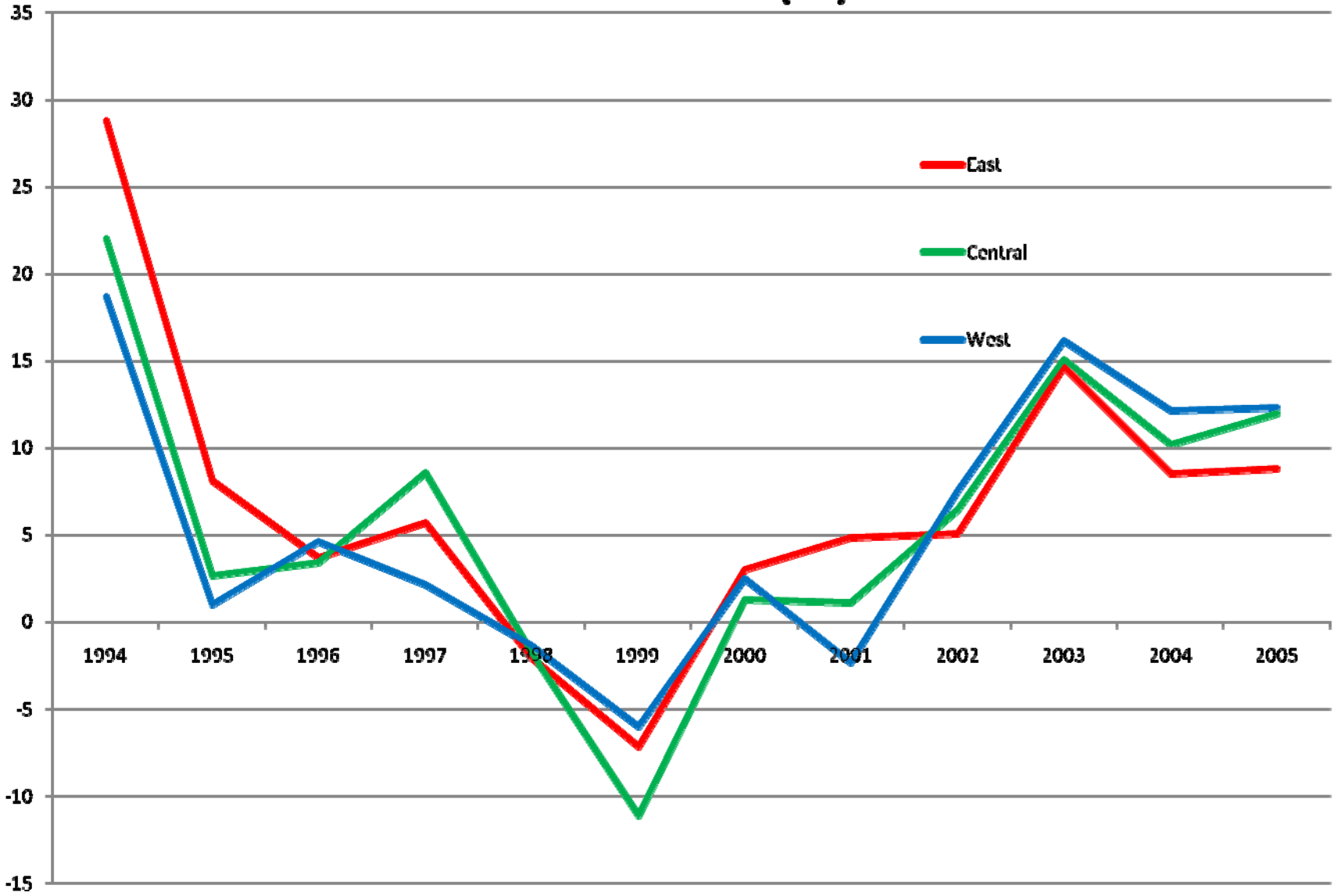
Regional TFP Change Rate 1993-2005, Stochastic Frontier (%)



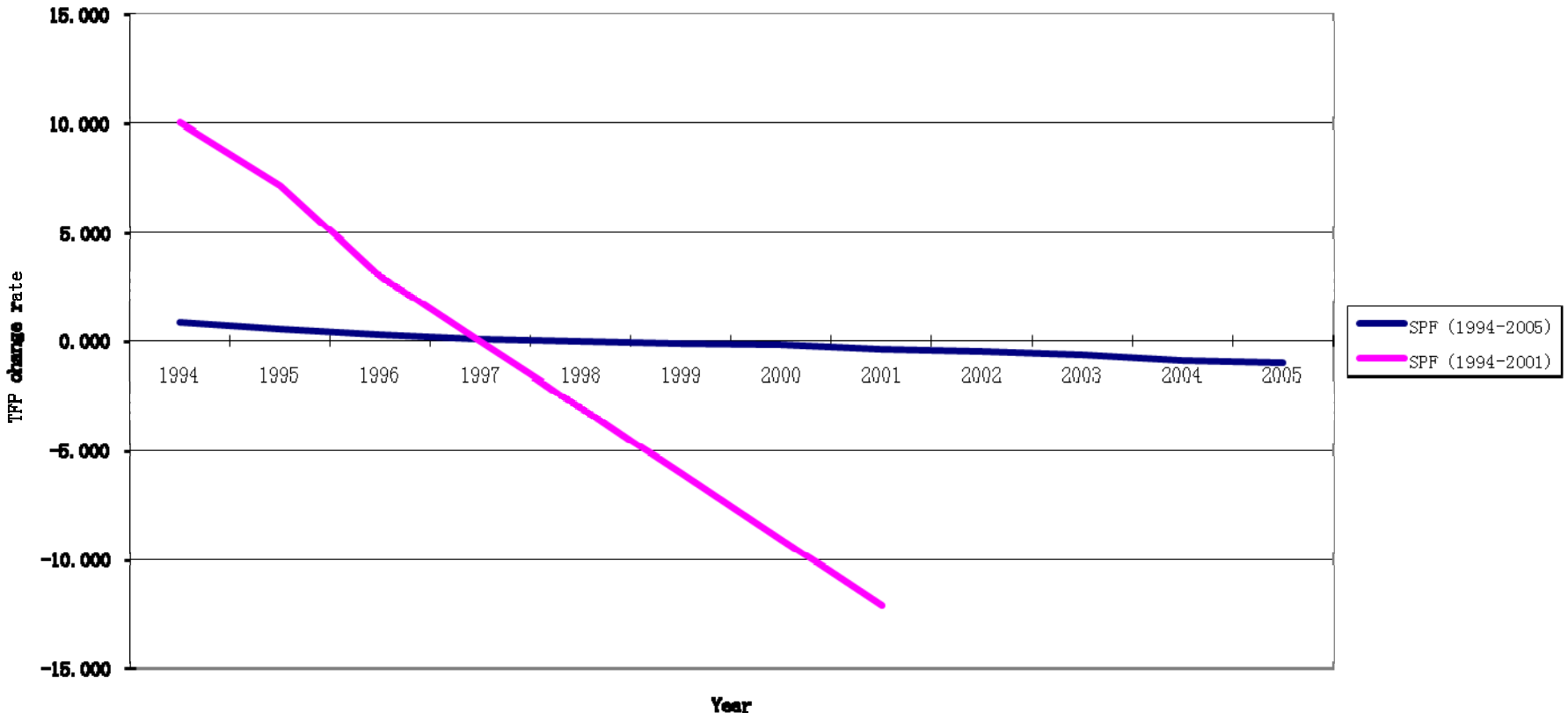
Regional Technical Change, SF
1993-2005



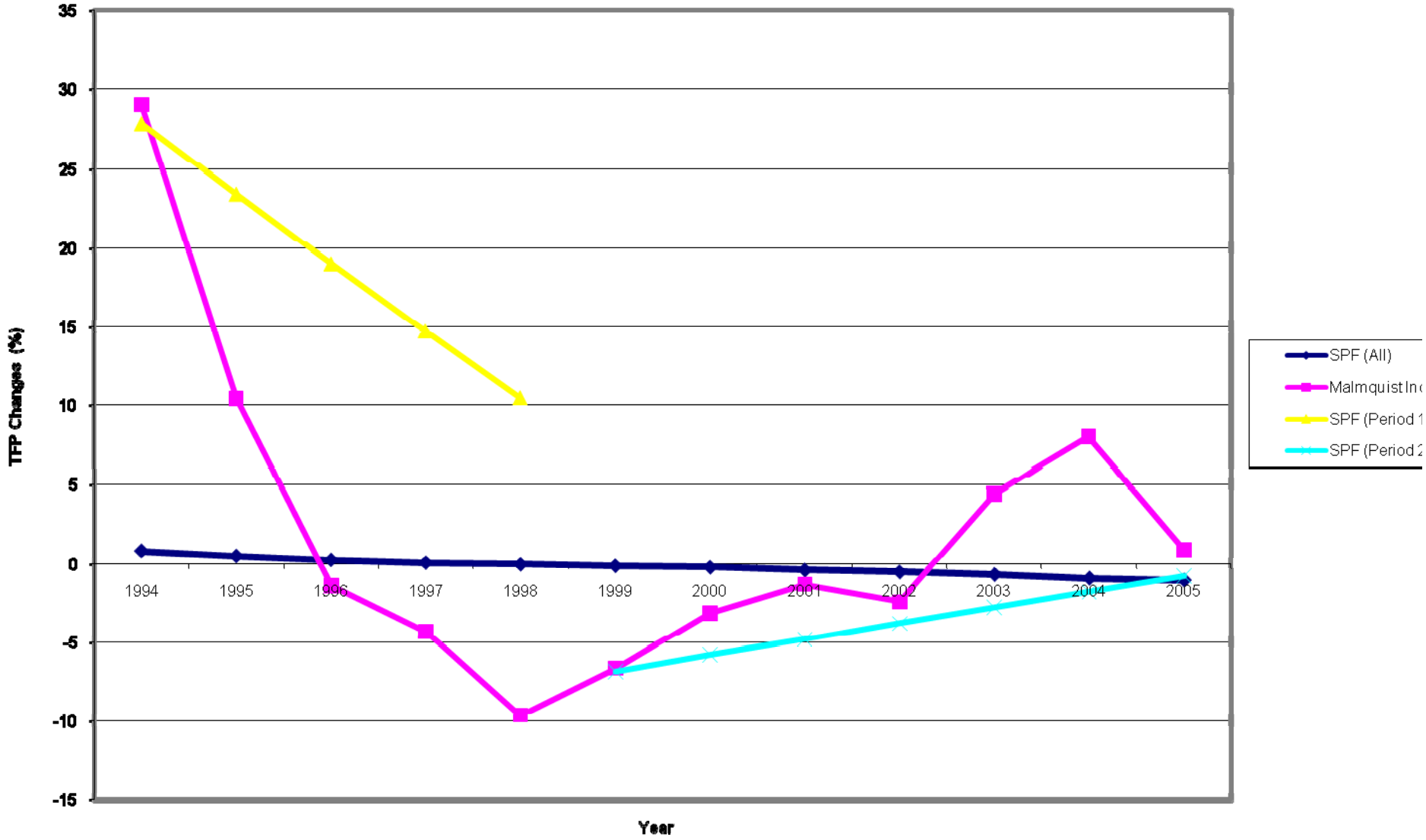
Rate of Technical Change by Region, MI, 1993-2005 (%)



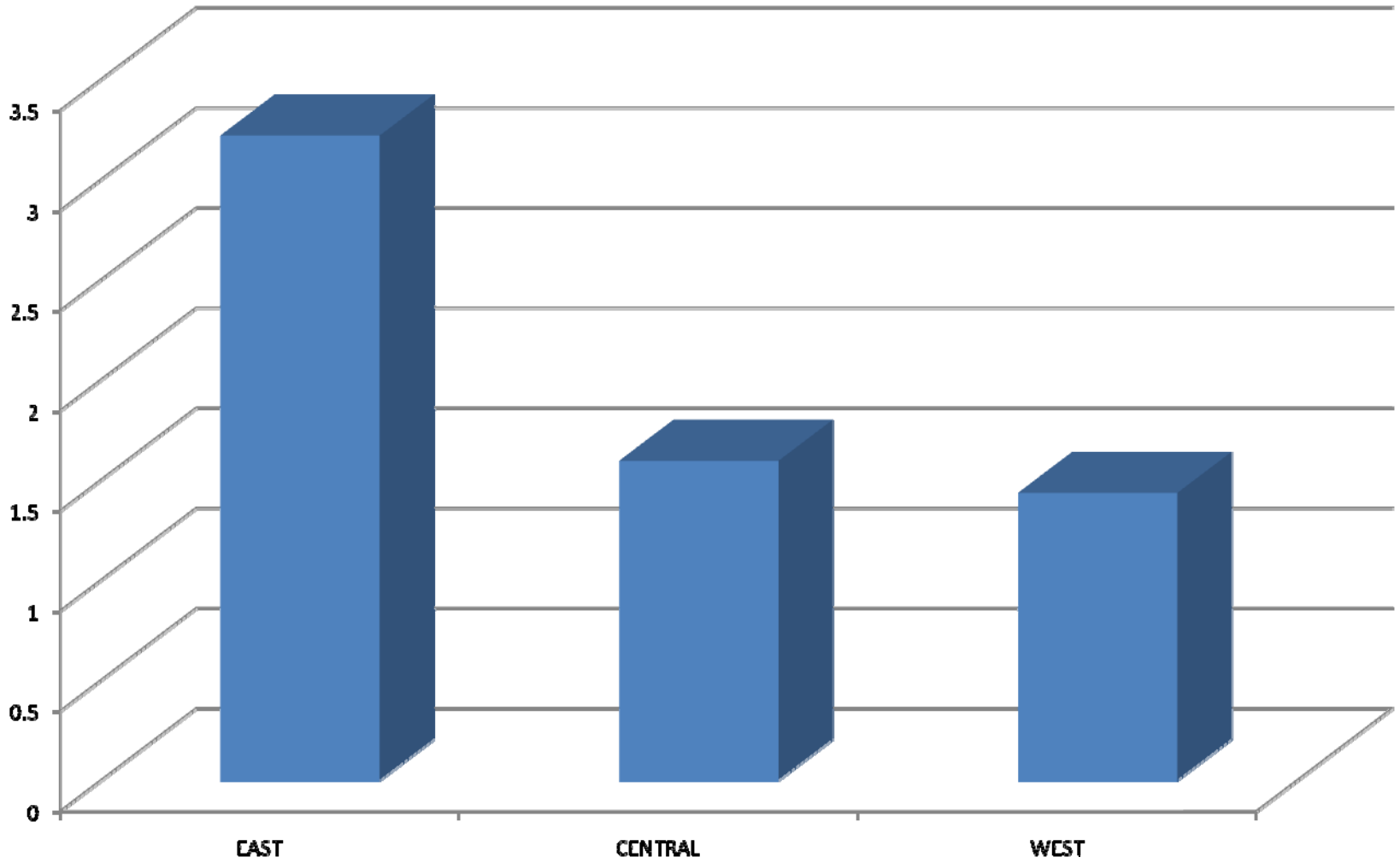
TFP Growth Rates, SPF
Different Period

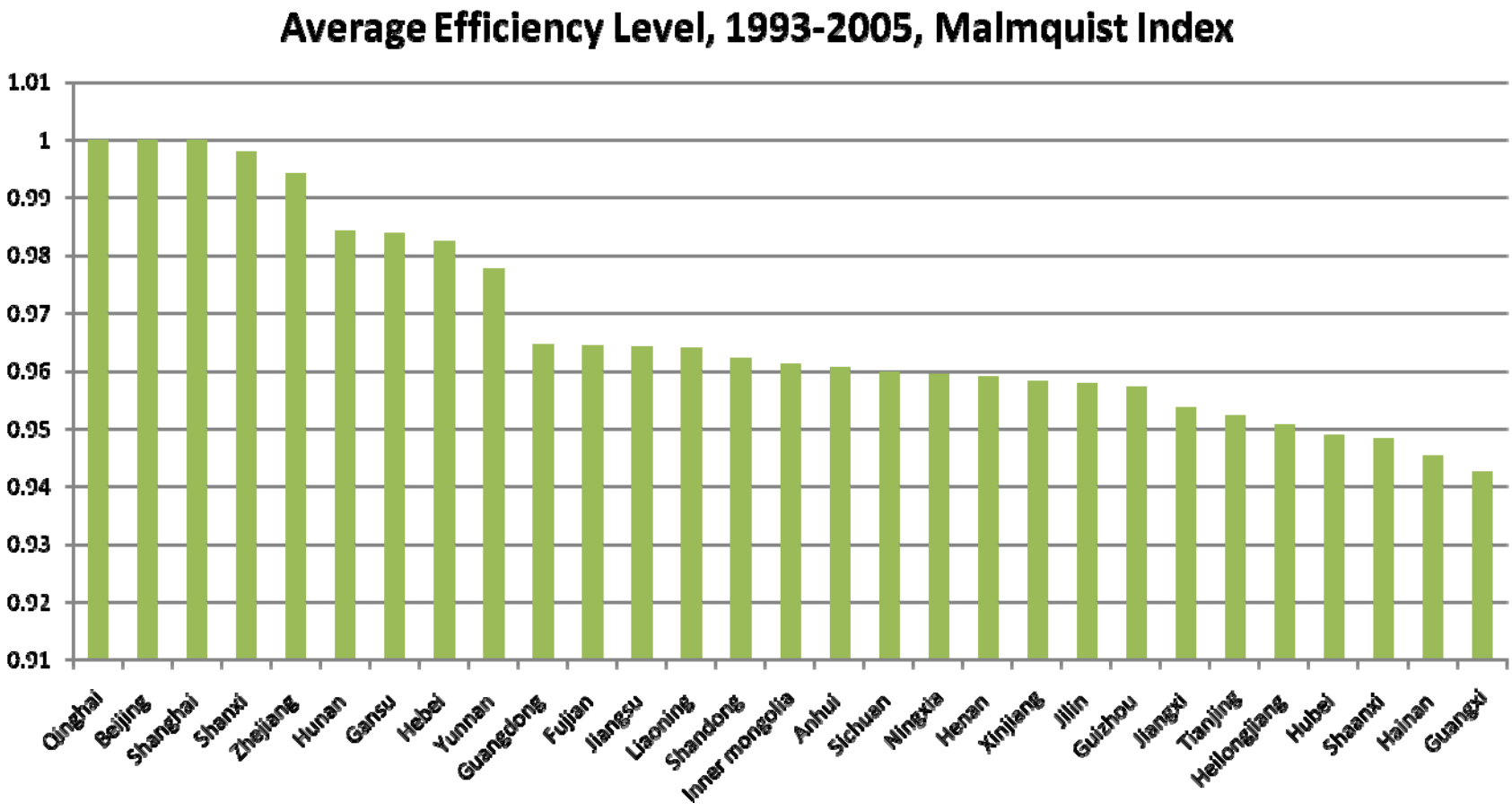


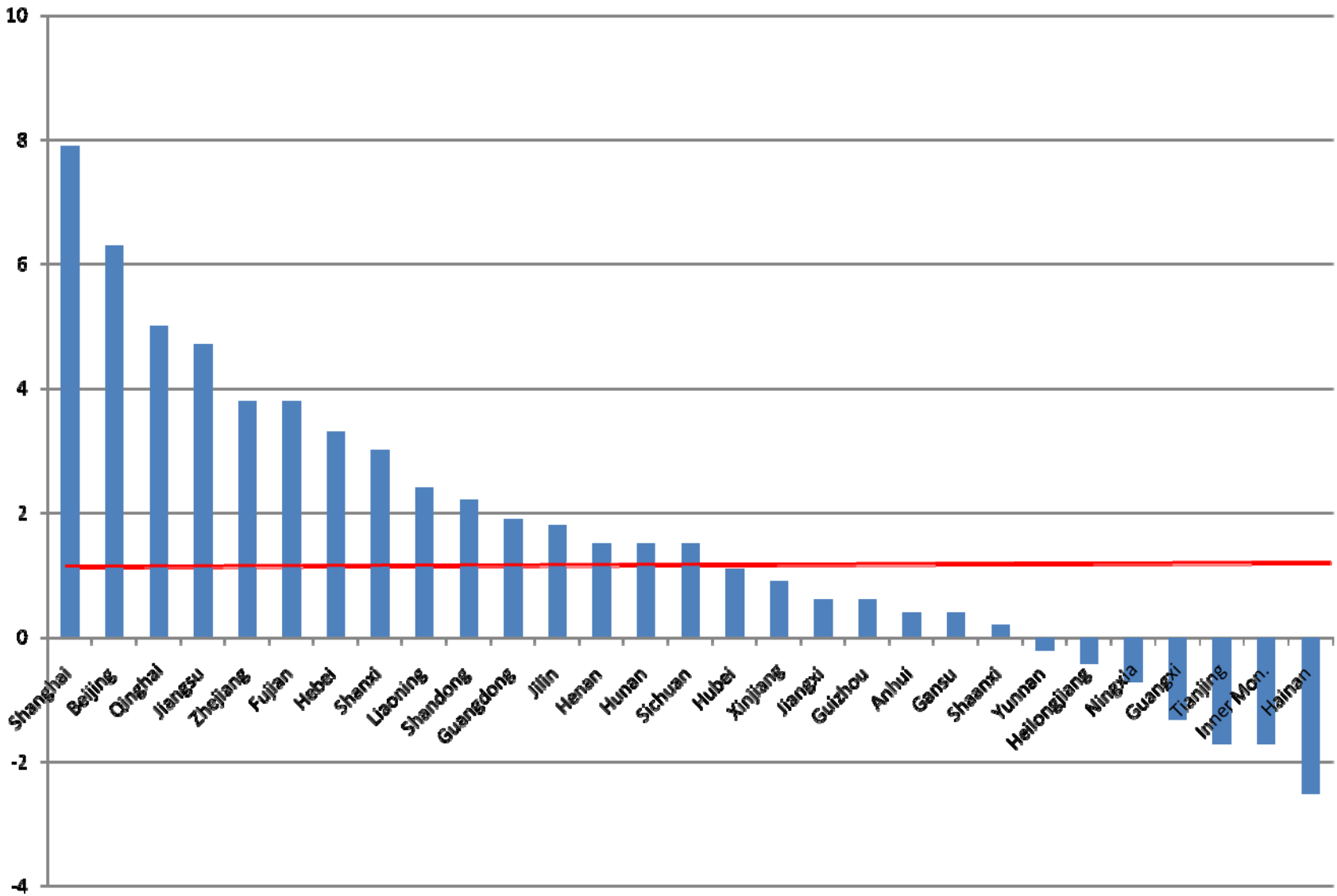
Estimation of TFP for Different Periods SPF and MI



TFP growth rates, Malmquist 1993-2004 (%)




Average Efficiency Level, 1993-2005, Malmquist Index
1.01
1
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
Qinghai
Beijing
Shanghai
Shanxi
Zhejiang
Hunan
Gansu
Hebei
Yunnan
Guangdong
Fujian
Jiangsu
Liaoning
Shandong
Inner mongolia
Anhui
Sichuan
Ningxia
Henan
Xinjiang
Jilin
Guizhou
Jiangxi
Tianjing
Heilongjiang
Hubei
Shaanxi
Hainan
Guangxi


Average TFP growth rates, 1994-2005
10
8
6
4
2
0
-2
-4
Shanghai
Beijing
Qinghai
Jiangsu
Zhejiang
Fujian
Hebei
Shanxi
Liaoning
Shandong
Guangdong
Jilin
Henan
Hunan
Sichuan
Hubei
Xinjiang
Jiangxi
Guizhou
Anhui
Gansu
Shaanxi
Yunnan
Heilongjiang
Ningxia
Guangxi
Tianjing
Inner Mon.
Hainan

What factors affect differences in TFP rates?

- Irrigation - YES
- Education - YES
- Public Expenditures in Agriculture – YES

What else did we learn?

- Potential role of institutional change in reversal in 1998
- Important to use alternative approaches
- Specification error could drive results in particular when trend reversals are present
- Evolution of each province

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- This study: 2%

- Output growth 1993-2005: 4.5%

- TFP Growth: 2%

East: 3.2%

Central: 1.6%

West: 1.4%

Shifting the frontier: Quinhai, Beijing, Shanghai with TFP rates of 6-8% (cash crops, fruits and vegetables)

Traditional ag. areas TFP rates of 2-3% (Shizuan, Shangdong, Jiangsu, Guangdong, Henan, Hebei, Hunan, etc.)

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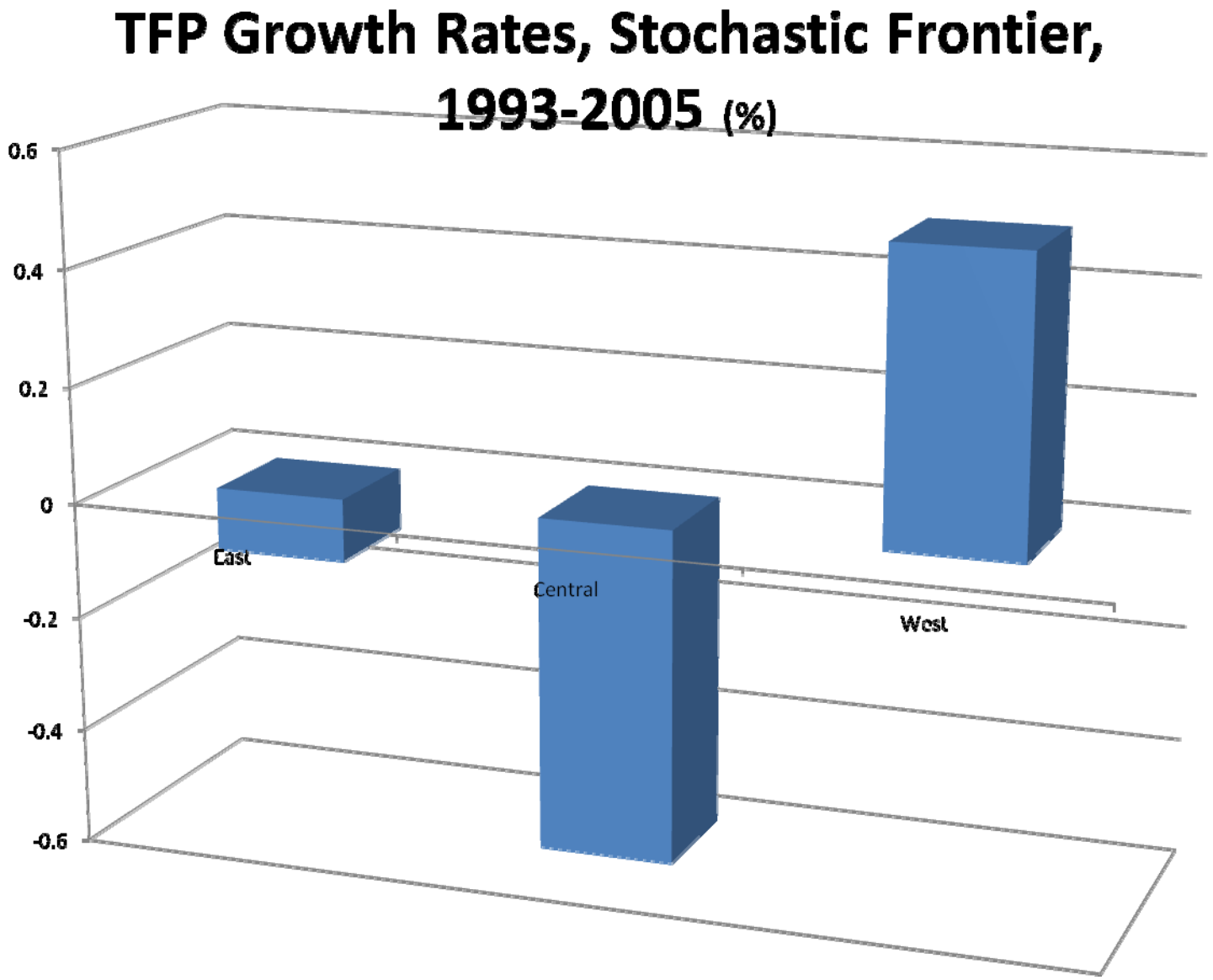
- **East includes: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi and Hainan.**

- **Central includes: Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan.**

- **West includes: Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xingjiang.**


TFP Growth Rates, Stochastic Frontier, 1993-2005 (%)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
East
Central
West